time slot 3 rather than its transmit time slot 3. Similarly, system C would successfully detect system A if its performed its monitoring during the receive interval for time slot 9. Thus, monitoring during the receive interval may be as successful at detecting the activity on a channel as monitoring during the transmit interval. System A, because it has a 2 millisecond frame interval, must monitor all 5 time slots during the 10 millisecond frame monitor interval as specified in SRO 15.321 (c). Thus it also has a better that 50% chance of detecting the transmissions of the other systems. Note that the same would be true if it monitored either its transmit or receive intervals as long as close to half the 10 millisecond monitor interval was monitored. From this simple example it can be seen that the systems will be no more likely to interfere with each other irrespective of monitoring during their receive or transmit intervals as long as the total fraction of listening during the 10 millisecond monitor interval is at least of the order of half the interval.

The illustration of figure 1 shows the timing for the systems at one particular instant of time. The section on timing accuracy of the SRO 15.321 (e) specifies that independent devices maintain a timing accuracy of 10 parts per million. This difference in timing between separate systems will, over time, allow the access windows of independent systems to drift by as much as 1 millisecond every 50 seconds. Thus the illustration of figure 1 becomes (approximately) as in figure 2, after one millisecond of drift has occurred.

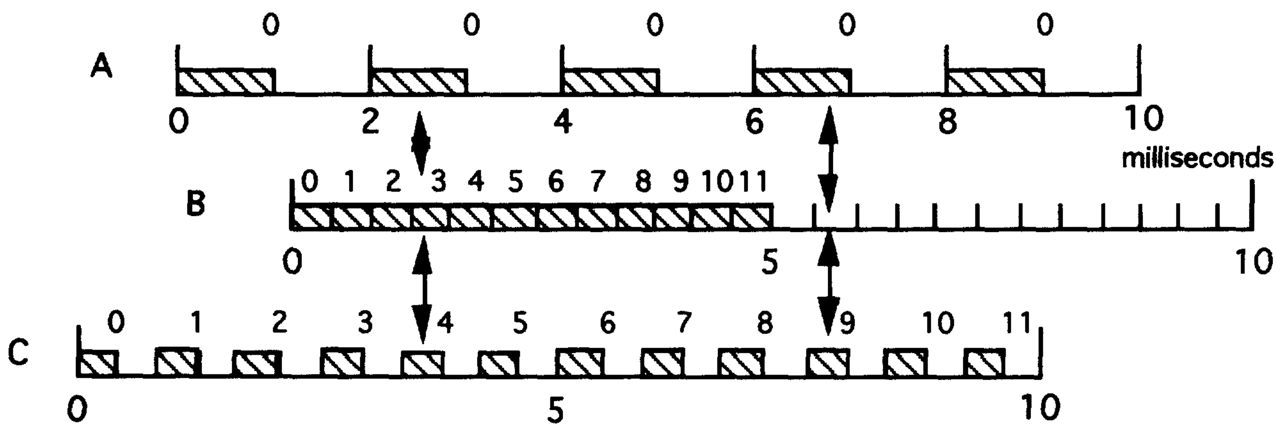

Figure 2 Transmit/Receive Timing Example after 1 millisecond timing drift

It can be seen that now system B when monitoring in its transmit time slot 3 will detect the transmissions of systems A and C and thus will defer the use of the channel and not cause interference. Note also that now, when monitoring transmit time slot 0, system B will miss seeing either system A or C, while 1 millisecond earlier time slot 0 would have detected the other systems. System C when monitoring time slot 9 will detect the transmission of system A but not system B. System A, because it must monitor 5 windows during the 10 millisecond monitor interval, will be as likely to detect the operations of both systems B and C irrespective of whether it monitors during its transmit or receive time windows. Again it can be seen that the probability of detecting another system's transmissions depends only on the overlap of the monitor intervals to the other devices transmissions, and is independent of the relation of the monitoring interval to the devices possible transmit interval.

It is important to note that the drifting of the time windows between the two dissimilar systems will cause the transmit and receive monitor intervals to overlap and change places over time. Monitoring during a transmit window at one instant is no guarantee that that interval will not drift to become equivalent to the receive window after a period of time. The timing accuracy constraints imposed by SRO 15.321 (e)[2] allow this to happen in a period of the order of a minute and thus it may happen about three times during the course of a typical three minute telephone call. Clearly, the requirement of the SRO 15.321 (c) to monitor only during the transmit interval is an unnecessary constraint when the transmit interval will drift over time to become a receive interval. A more general solution is to allow devices to monitor either the transmit or receive intervals (or both).

In the filing of the etiquette by WINTech and the petition by Northern Telecom, wording was provided to allow multi-carrier devices to access channels by monitoring during the receive interval if the monitor period is close to 50% of the 10 millisecond monitor interval, and the access was further restricted to the same 1.25 MHz frequency channel that the device may already be active on[3]. These conditions, as the above figures and

[2]The SRO makes a requirement for 10 ppm accuracy for the timing on TDD systems. For two unsynchronized systems the drift rate could thus be of the order of 1 millisecond each 50 seconds. Increasing the stability requirements is not a practical way to prevent interference. Higher stability will reduce the drift rate, but at significant cost. The higher stability requirements would mean high precision timing units which are expensive to build and calibrate, are often bulky and would seriously impact the cost, battery life and consequent "talk-time" of the equipment and would not solve the interference problem as synchronization is not guaranteed.

[3] Northern Telecom recommended that the following paragraph be added to 15.321 (c) to account for multi-carrier operation :

discussion illustrate, allow access under controlled conditions that are less likely to cause interference to other systems than the LBT simply constrained to monitor only the transmit interval.

The Near-Far Condition

A frequent condition in which the LBT mechanism fails to provide protection against interference between systems is the "near-far" condition. This is illustrated in figure 3. In this case, handset 2 (HS-2) is operating near the limit of its range from its base station (BS-2) and coincidentally near the location of base station 1 (BS-1). If BS-1 scans for a free channel (perhaps to contact handset (HS-1)), it will detect a low level during the receive interval for the handset of the foreign system (HS-2). The monitored level will be below the access threshold if the base station BS-2 is far enough away from (or is perhaps additionally blocked by a wall) from BS-1[4]. If the base station BS-1, begins transmission during this "quiet" interval it will disrupt the communication between HS-2 and BS-2. This will be disruptive to the existing users. The LBT mechanism has not protected against interference in this case. The base-station has chosen to transmit during the "quiet" interval which is the time at which the handset (HS-2) is most sensitive to interference. In this particular example, it would be best for the base station (BS-1) to synchronize its activity to the foreign system by arranging its transmissions to match the transmit interval of the portable (HS-2). Thus in this case the best time to transmit to achieve the least interference to the existing system is to transmit during the "noisy" transmit interval rather than the quiet receive interval.

15.321 (c)(11) Before initiating transmission, devices which are prevented from monitoring during their intended transmit interval due to receiver blocking from the transmissions of a co-located (within one meter) transmitter of the same system, may monitor the portions of the time and spectrum windows in which they intend to receive over a period of a least 10 milliseconds to determine if the access criteria are met so long as the monitored spectrum is within the 1.25 MHz frequency channel(s) already occupied by that device or co-located (within one meter) co-operating group of devices. The receive monitoring interval must total a least 45% of the 10 millisecond interval.

[4] Rules 15.321 (c)(2) and 15.321 (c)(5) discuss the thresholds to be used to determine channel access.

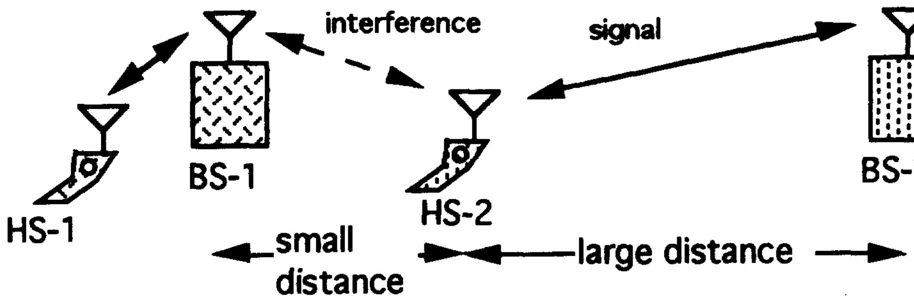

Figure 3 Illustration of "near-far" Conditions

This example provides a further illustration of the non-guarantee of interference from the LBT mechanism and that it need not be constrained to monitor only during the devices intended transmit intervals.

The best mechanism to assure non-interference is to listen for the entire 10 millisecond monitor interval and, through knowledge of all possible Transmit and Receive timing window plans used by all devices, infer the nature of any systems operating in the neighborhood. With the knowledge of which systems are operating as neighbors, the monitoring information can be used to plan transmissions to reduce the proability of interference. This is not practical to implement as devices deployed in the field would need to be frequently updated with information on the channel plans for new systems. It would also require rather too much memory and computing resources in each device.

Summary

The points to note are that due to the "near-far" problem and the drifting of the timing windows of systems, the LBT mechanism does not guarantee non-interference to existing channel usage. The key to success for the LBT operation is for the monitoring interval to overlap the transmission of the other devices. If there is overlap of the intervals, then the LBT operation will assure a low probability of interference. The probability of this overlap is entirely independent of any relation between the transmit and receive intervals of the the systems and is a function of the relative timing windows of the systems. Without synchronization between systems the relationship of the windows is indeterminate and will change over time. If the monitoring interval totals at least of the order of 50% of the 10 millisecond frame basis, then the probabilty of detecting other systems (with equal time intervals assigned for transmit and receive) is very high irrespective of its relation to the monitoring device's future transmit and receive intervals. The additional access mechanism does not increase the probability of interference between systems and is not a "bypass mechanisn" nor a "slippery slope" to undermine the LBT basis of spectrum sharing. Thus the Commission is urged to accept the petition of Northern Telecom to include provisions which allow for the montoring interval to not be constrained to only the transmit interval under specified conditions.

CERTIFICATE OF SERVICE

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